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The NEOTOMA ECOLOGICAL and BIOCLIMATIC LABORATORY

Special Report No. 1

THE NEOTOMA ECOLOGICAL AND BIOCLIMATIC RESEARCH PROGRAM AS OF 1961

by

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THE NEOTOMA ECOLOGICAL AND BIOCLIMATIC RESEARCH PROGRAM AS OF 1961[1]

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Neotoma is the name long given to a small wooded valley located in south-central Ohio largely owned by Dr. Edward S. Thomas, Curator of Natural History of The Ohio State Museum. The name was originally suggested to Dr. Thomas by the late James S. Hine[2] since it represents the site of the first collection in Ohio of the Allegheny Woodrat (*Neotoma floridana magister* Baird). This valley has been the site of various ecological researches for more than 40 years (see accompanying bibliography).

Geographically Neotoma is located 8.5 miles SSE of Lancaster, Ohio in Hocking County (NE ¼ Sec. 16 Goodhope Township), the center of the valley being located approximately 82° 33′ 18″ W. Long. and 39° 35′ 55″ N. Lat. Physiographically, the valley occurs within the dissected Appalachian Plateau and within a local relatively hilly area popularly known as the Hocking Hills. It occurs approximately 10 miles from the western escarpment of the Appalachian Plateau and within a few miles of the maximum extent of both Illinoian and Wisconsin continental ice sheets as they occurred within south-central Ohio.

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[1]A cooperative project of the Ohio Agricultural Experiment Station, The Ohio State University, and the United States Atomic Energy Commission [contract No. AT(11-1)-552].

[2]A close friend of Dr. Thomas, former member of the Department of Zoology and Entomology of The Ohio State University, and immediate predecessor of Dr. Thomas as Curator of Natural History of The Ohio State Museum.

Wolfe *et al.* (1949) aptly described the area as follows:

> Neotoma is a typical, cliff-bordered, cove-headed valley of the region. It is about a mile in length, and heads northwest. On the SW-facing side, 50 foot cliffs rise vertically above the talus slope and extend to the waterfall. On the NE-facing side discontinuous cliff remnants about 30 feet in height occur. The cliffs converge at the waterfall, forming a rock rimmed cove into which Arbutus Run drops 40 feet.

Aerial photos of Neotoma during both winter and summer periods are included in Figures 1 and 2.

An extensive ecological and microclimatic research program was initiated at Neotoma during 1939 by Wolfe, Wareham, and Scofield of the Department of Botany and Plant Pathology of The Ohio State University and the associated field studies were continued until interruption early in 1944 by World War II. However, analysis and synthesis of data continued culminating in the publication of the most complete ecological

Fig. 1.—Aerial view of Neotoma during winter period.

and microclimatic work of its kind ever published in North America (Wolfe *et al.* 1949). These studies were briefly described within this publication as follows:

> Every weekend during the valley investigation between 100 and 300 instruments were read and reset, and data and field observations were recorded. In addition, a number of special trips of one to several days' duration were made at different seasons, during which time several factors were measured at 15-, 30-, or 60-minute intervals for periods of five to 24 hours. In all, about 300 trips were made to the valley by the end of 1943. Data were recorded concerning the following phenomena: minimum and maximum air temperatures near the substrate; minimum and maximum air temperatures beneath the leaf litter; minimum and maximum air temperatures five feet above the substrate; soil temperatures at a depth of 9-12 inches; plant temperatures; relative light intensities; precipitation; evaporation from atmometers; soil moisture fluctuations; vapor pressure; flowering periods of plants; seasonal variations in the rates of plant growth; and seasonal conditions of plants.

Fig. 2.—Aerial view of Neotoma during summer period.

The above ecological and bioclimatic research program was reinitiated by Wolfe and Gilbert in 1952 and has been continued and expanded ever since. The current method of approach, however, differs considerably from that associated with the earlier studies in that research efforts have been concentrated within the major vegetation types occurring in the central portion of the valley, electrically operated instrumentation is being used, and greater emphasis has been placed on studies concerning specific plant physiological phenomena as they occur in the field.

A major portion of the current ecological and bioclimatic research program is being conducted within five vegetation types which collectively comprise the vegetation of the central portion of Neotoma extending from atop the western ridge to, but not including, the ridge of the opposing slope. Specific communities involved are: Mixed Mesophytic, Chestnut Oak, Mixed Oak (formerly Oak-Chestnut), Oak-Tulip (also formerly Oak-Chestnut), and an old field community complex occurring within the open valley. These woody communities dominate the lower northeast-facing slope, western ridge top, southwest-facing slope, and upper northeast-facing slope habitats respectively and were previously briefly described by Wolfe *et al.* (1949), Wolfe and Gilbert (1956), and Gilbert and Wolfe (1959). A detailed description of the above mentioned woody communities will be included in another Neotoma Special Report concerning the population dynamics of major Neotoma forest communities. Permanent study areas have been established within the above mentioned communities and their locations are indicated in Figure 3.

BIOCLIMATIC INVESTIGATIONS

Investigations concerning the climates of the above mentioned communities were reinitiated in 1952 with the installation of a multipoint temperature recorder within the Mixed Oak community at station #3. These studies have since been broadened to include all of the above mentioned vegetation types, with the exception of the Oak-Tulip community, and extended to include other environmental factors. At the present time 12 recorders, most of which are electrically operated and located in the centrally situated field headquarters (Fig. 4), are being used in conjunction with approximately 150 sensing elements for the recording of

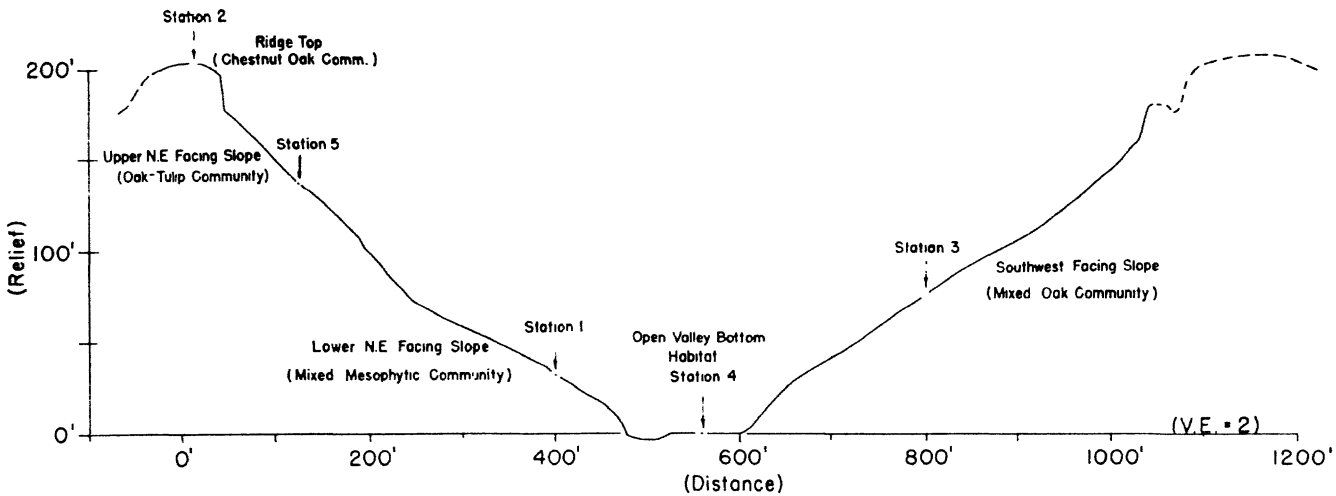

Fig. 3.—Cross section of central portion of Neotoma indicating distribution of vegetation types and location of permanent study areas (distance and relief in feet).

data concerning the bioclimatic factors listed in Table 1. Figure 5 illustrates the type of instrument tower being used for exposure of sensing elements at various levels within, as well as above, the three forest communities included within the bioclimatic investigations.

ECOLOGICAL AND ASSOCIATED INVESTIGATIONS

Major ecological and associated investigations being conducted at the time of this writing (January, 1961) include the following:

Phenology.—Studies concerning the phenology of approximately 400 woody and herbaceous species occurring within the dominant forest and old field communities of Neotoma have now been underway for nine years. Specifically, these studies have involved the weekly collection (biweekly during winter months) of field notes concerning such phenological events as breaking of dormancy, leaf expansion, flowering, fruiting, leaf coloration, leaf abscission, fruit abscission, shedding of seed, longitudinal stem growth, germination, among numerous others. Sufficient data have now been obtained for the synthesis of a "Calendar of

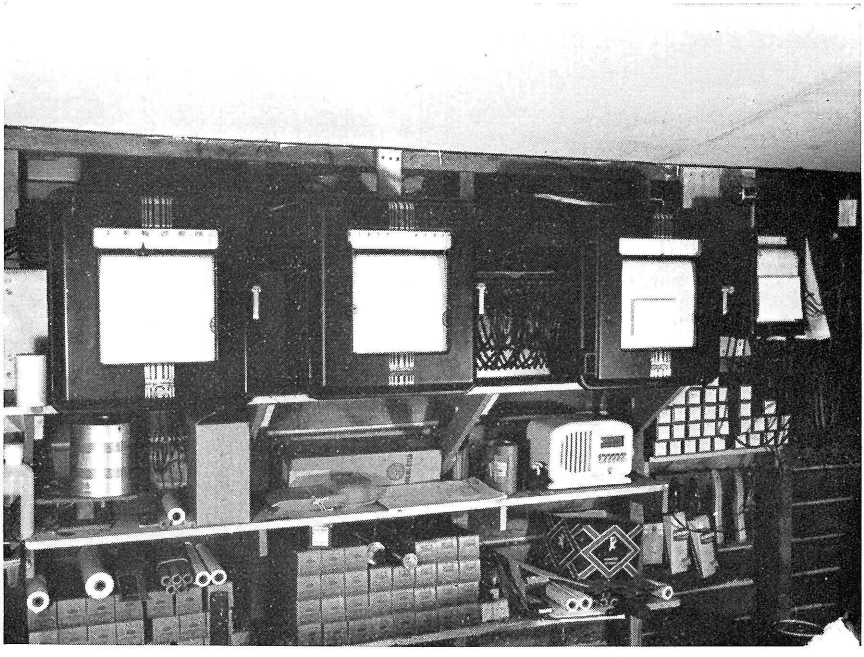

Fig. 4.—Recording equipment within centrally located field headquarters.

Phenological Events" for many of the species being studied, especially the important species of the old field herbaceous vegetation of the open valley bottom habitat.

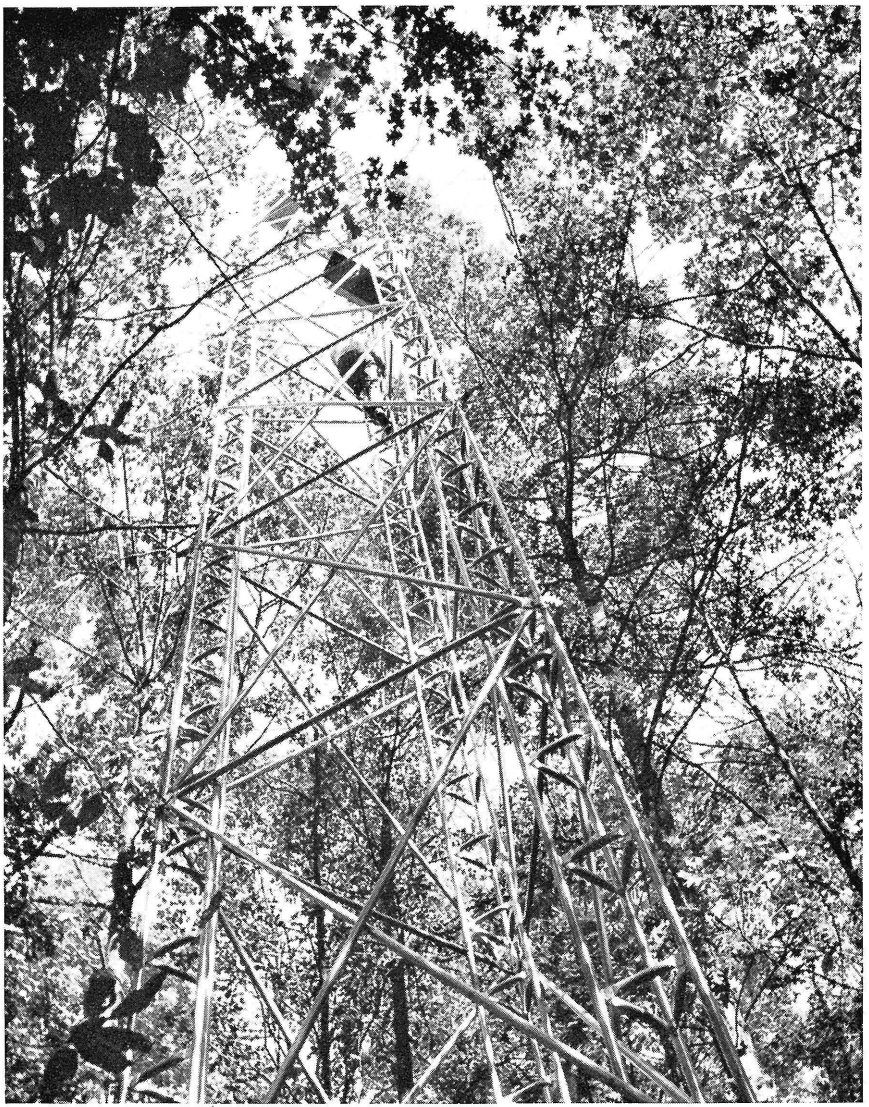

Fig. 5.—Instrument tower located within Mixed Oak community at station #3 for exposure of various sensing elements being used within Neotoma bioclimatic investigations (similar towers within Mixed Mesophytic and Chestnut Oak vegetation at stations #1 and 2.

TABLE 1.—Bioclimatic and Associated Factors Being Investigated at Neotoma as of January, 1961

A. Mixed Mesophytic, Chestnut Oak, and Mixed Oak Forest Communities.

1. Solar radiation at atop canopy level (Eppley pyrheliometer)
2. Solar radiation at forest floor (Eppley pyrheliometer)
3. Solar radiation reflected by canopy (Eppley pyrheliometer)
4. Soil temperature at several levels (thermocouple)
5. Air temperature at several levels from forest floor to above canopy (thermocouple)
6. Precipitation atop canopy (tipping bucket gage)
7. Throughfall (special instrumentation)
8. Soil moisture at several levels (Coleman units)
9. Atmospheric water vapor at several levels (Serdex and Belfort hygrothermographs)
10. Wind velocity above canopy (Belfort Aerovane)*

B. Old Feld Herbaceous Vegetation of Valley Bottom.

11. Solar radiation atop vegetation (Eppley pyrheliometer)
12. Soil temperature at several levels (thermocouple)
    a. under bare soil
    b. under sod and clipped vegetation
13. Air temperature at several levels (thermocouple)
    a. above bare soil
    b. above soil with sod and clipped vegetation
14. Precipitation received (weight recording gage)
15. Soil moisture at several levels (Coleman units)
16. Depth of soil water level (Leupold & Stevens recorder)

*Above Chestnut Oak community only.

Radial Growth of Woody Stems.—Studies concerning radial growth of woody stems were initiated within the Mixed Mesophytic community during February, 1955, at which time 11 individuals representing the same number of species were prepared for radial growth measurement by use of dendrometer similar to that of Daubenmire (1945). These studies were expanded to the point that 41 individuals representing

20 species included within the Mixed Mesophytic, Chestnut Oak, and Mixed Oak communities were being measured for radial growth by late 1959. The collection of radial growth data by use of dendrometer was terminated during late September, 1960. Analysis of part of the data has been completed (Phipps, 1960) and two Neotoma Special Reports concerning these data are in manuscript. Constant measurement of radial growth of woody stems was initiated within Neotoma in 1956 with the installation of a Fritts dendrograph (Fritts and Fritts, 1955) and has been expanded to include five Fritts dendrographs and two electric dendrographs (Phipps and Gilbert, 1960) monitoring selected canopy dominants of the Mixed Mesophytic, Chestnut Oak, and Mixed Oak communities.

Longitudinal Growth of Woody Stems.—The installation of instrument towers within the Mixed Mesophytic, Chestnut Oak, and Mixed Oak forest communities provided relatively easy access to terminal stem segments of canopy and sub-canopy individuals and consequently studies concerning longitudinal woody stem growth were initiated. Preliminary data have now been obtained during two growth seasons from one individual each of Scarlet Oak *(Quercus coccinea* Muenchh.[3]), Black Oak *(Q. velutina* Lam.), Chestnut Oak *(Q. prinus* L.), and Tulip-tree *(Liriodendron tulipifera* L.).

Population Dynamics Investigations.—Detailed studies concerning the population dynamics of the Mixed Mesophytic, Chestnut Oak, and Mixed Oak vegetation at stations #1, 2, and 3 respectively are presently in their seventh year and a sufficient quantity of data has now been obtained from permanently established quadrats for the synthesis of a meaningful picture of the population dynamics of these communities. This information has been analyzed and will be reported within a future Neotoma Special Report.

Taxonomic Investigations.—A taxonomic survey is presently being completed of the vascular flora of the four forest study areas as well as the open valley bottom habitat dominated by old field vegetation. This survey includes the preparation of voucher specimens which are housed within the Plant Ecology laboratory of The Ohio State University. An additional taxonomic survey, again including preparation of voucher

[3]Nomenclature that of Gray's Manual of Botany, 8th edition (Fernald, 1950).

specimens, is also being completed of the herbaceous vascular flora of 29 permanently established 10 × 10 meter quadrats being used within the population dynamics studies of the four study forest communities.

Considerable taxonomic effort is also presently being expended in studies concerning the identification of various members of the red oak group occurring within Neotoma (Zamierowski, 1960), special emphasis being placed on the use of bark pigment data obtained by chromatographic techniques.

Investigations Concerning Internal Water Relations of Woody Stems.—Preliminary studies have been completed concerning the internal water dynamics of woody stems, as indicated by changes in electric resistance, and the relationships of such dynamics to the environmental complex (Koch, 1960). Specifically, the resistance of the inner bark and outer xylem tissues of two Mixed Mesophytic canopy individuals (Tulip-tree and Chestnut Oak) occurring at station #1 was constantly measured over a 21 day period during late summer and the information related to various bioclimatic data obtained at the same location. These studies are presently being refined and will be reinitiated during early spring, 1961.

Soil Classification Studies.—Studies concerning the classification and distribution of major Neotoma soil types have now been underway for several years for the purpose of providing information greatly needed in the solution of a variety of Neotoma ecological problems as well as a classification study of the major soil types of the dissected Appalachian Plateau. A large portion of the latter work is being conducted by graduate students and faculty of the Department of Agronomy of The Ohio State University (Finney, 1959).

Soil Moisture Dynamics Investigations.—Weekly, occasionally twice weekly, soil moisture sampling was initiated in November, 1954, a minimum of three and a maximum of five random samples being collected by soil tube at both one to three and six to nine inch depths within the Mixed Mesophytic and Mixed Oak study areas (stations #1 and 3) as well as the valley bottom (station #4). A preliminary report concerning the soil moisture dynamics of these habitats during the years 1955 to 1957 inclusive was published by Gilbert and Wolfe in 1959.

The above mentioned studies were later expanded to include the Chestnut Oak community at station #2 and considerably refined by use of electrical sensing units and associated multipoint recorder which, at the

time of this writing, enables the near constant measurement and recording of soil moisture at two, five, 10, and 24 inch depths within all four study habitats.

Radiological Investigations.—Preliminary studies concerning the amount and distribution of radioactive materials within Neotoma soils are being conducted and concern both naturally occurring radioactive isotopes as well as those derived from fallout. The present studies specifically concern the distribution with soil depth of fallout isotopes Cs^{137} and Sr^{90}, and the naturally occurring isotope K^{40} at numerous locations along a transect extending from ridge top to ridge top across the central portion of the problem valley.

Soil Movement Investigations.—Studies concerning down-slope movement of the major soils of opposing slopes of Neotoma and the relating of these movements with various soil factors are now within their second year, measurement of soil movement at various depths being accomplished by use of linear motion potentiometers in conjunction with a multipoint recorder. This work is associated with the research program of the Department of Geology of The Ohio State University.

Insect Ecological Investigations.—Two insect ecological investigations are currently within their third year at Neotoma and concern basic ecological relations of the ants *Formica exsectoides* Fab. and *Camponotus ferrugineus* Wheeler and several species of the family *Culicidae* (mosquito) which usually reproduce in tree holes or closely related habitats. This work is associated with the research program of the insect ecology area of the Department of Zoology and Entomology of The Ohio State University.

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